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GLOBALIZATION, INTERNATIONAL TRANSPORT AND THE GLOBAL ENVIRONMENT: A RESEARCH AND POLICY CHALLENGE

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Spatial movements of people and goods have shaped a dynamic geographic landscape. Our era is no exception to this historical trend. Indeed, our modern world is in a continuous state of flux. Modern transport systems have created an unprecedented rise in mobility, both regionally and worldwide. The action radius of the 'homo mobilis' is still on a rising trend and for the time being there are no compelling reasons that would bring this trend to a halt. The ever rising mobility pattern applies to all types of movement: work, business, shopping and leisure. The same tendency can also be observed in freight transport: at both the metropolitan/regional and the international level, a clear rise in freight movement has been observed, a rise that is even higher than the increase in personal mobility. Spatial dynamics have become a characteristic feature of mankind. This is in particular reflected in recent globalization trends. Such are the concerns of the four articles in this special issue.

Globalization is a concept of increasing interest. It is a 'vogue word' that refers to the broad area of increasing internationalization of markets, changing consumption patterns and the shifting of industrial activities all over the world. The driving forces are, *inter alia*, the liberalization of international trade, the rise of new markets, technological developments in the field of telecommunications and decreasing transportation costs. In globalization studies much attention has

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been given to the economic consequences of changing production and consumption patterns. However, less attention has been given to the transport and environmental consequences of globalization. In particular, the effects of globalization and related international transport on the environment – both globally and locally – have been largely neglected. The main question to be addressed here is: What are the effects of globalization and international transport on the emission of carbon dioxide?

The worldwide liberalization trends have created conditions favourable for the internationalization of our economies. These internationalization trends may have large and multiple impacts on the transport system and the global environment. The increase in greenhouse effects is a particular major environmental problem. There is a growing concern that emissions of carbon dioxide and other greenhouse gases resulting from human activities might cause an increase in the earth's surface temperature, and change the climate of the earth by means of an enhanced greenhouse effect. For example, carbon dioxide has been responsible for 55% of the enhanced greenhouse effect in the past, and is likely to remain so in the future. Other important greenhouse gases are water vapour and ozone.

Transport is a significant contributor to the greenhouse effect. Worldwide, transport produces 20% of the harmful emissions, while agriculture and deforestation produce 25% and power generation 25%. Although other sectors also contribute considerably to the emission of greenhouse gases, the contribution of the transportation sector is expected to increase dramatically. Several trends indicate a steady growth of both goods and passenger transport. On the other hand, the development of new transportation technologies may reduce the negative environmental consequences of transport.

The relationships between globalization, international transport and the global environment involve a large number of processes and interactions. Many factors influence future economic developments and the introduction of new transportation technologies. The transport sector is interrelated with social and economic developments, and is subject to numerous political and institutional constraints. The future developments of globalization, transportation and the environmental consequences are uncertain. How will the globalization process develop? What will the impact be on the use of international transport and the development of new technologies? How will this affect the global environmental quality?

Reliable and comprehensive information about these future develop-

ments is a necessary condition for making 'right' policy choices. Unfortunately, existing information is often incomplete and sometimes unreliable. The lack of information and the long time scales inherent in its production lead to significant uncertainty. To reduce these uncertainties, decision-makers need decision support tools. One way to deal with uncertainty is to construct various scenarios and examine the way different policy options perform in each of them. In this context, a scenario is a description of a hypothetical future state of the world, including a consideration of major uncertainties encountered in moving far into the future. Scenarios are not predictions or forecasts about the future; nor do they represent the most likely future developments. Scenarios do not tell us what *will* happen in the future; rather they tell us what *can* happen.

Clearly, the linkage between globalization and greenhouse gases involves a complex structure. In a simplified and structural way this is depicted in Fig. 1.

The concept of globalization can be operationalized by using the four effects of globalization on the economy distinguished by the OECD, namely:

- Scale effects: globalization will lead to changing world outputs.
- Structural effects: globalization will generate shifts in the composition and location of production and consumption activities.
- Technology effects: different technology paths will be promoted.
- Product effects: different product mixes will be produced and consumed.

These effects, which will be described in more detail below, also have consequences for the environment. On the one hand, increasing production and consumption (scale effects) will lead to more environmental pressure, such as the use of natural resources and the emission of polluting matter into air, water and soil. On the other hand, structural changes and technology effects can offer new possibilities. Hence, it appears that eventually the result of globalization on the environment is dependent on changes in these four effects.

As mentioned previously, the consequences of globalization for the transport sector can be described in terms of scale, structural, technological and product effects.

1. SCALE EFFECTS

Scale effects refer to changes in the volume of transported goods as

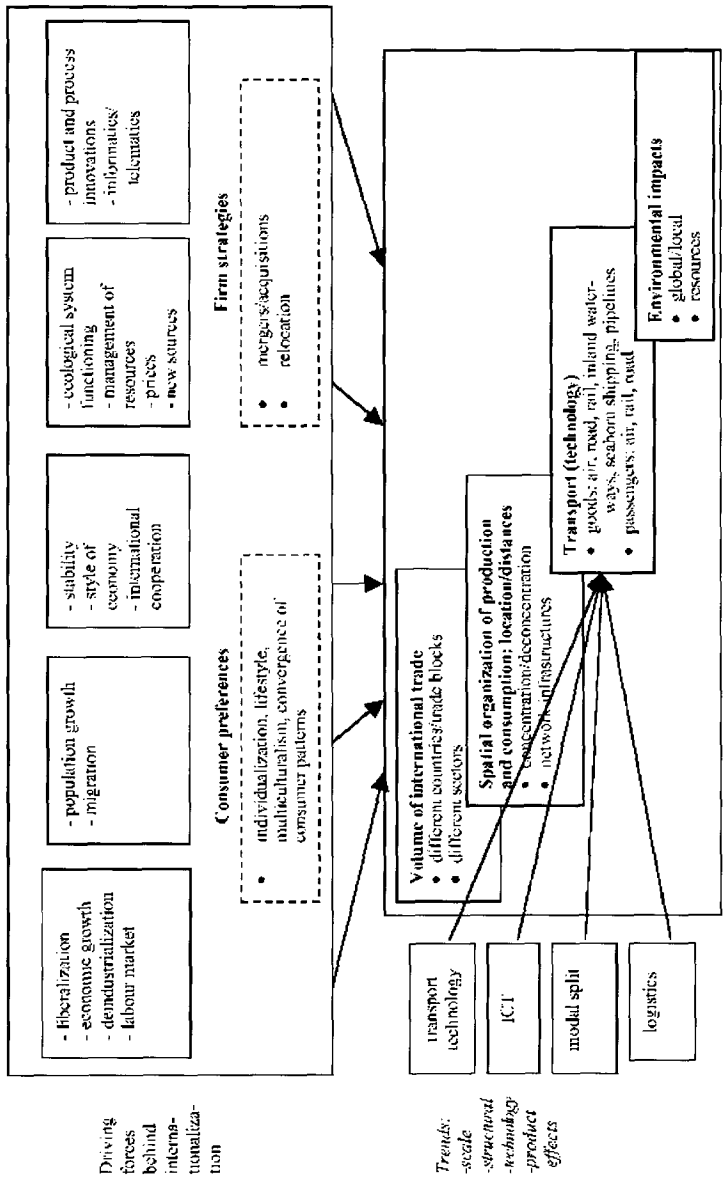

FIGURE 1 A multi-layer approach for tracing the effects of internationalization

well as to changes in modal split. In general, it is assumed that globalization results in expanding world output. However, this does not merely imply an increase in carbon dioxide emissions. First, expanding world output may be caused by a higher share of services. Second, the increase in production and consumption may result from production and consumption of more products of high value but low volume. Furthermore, it should be recognized that it is also possible that changes in the modal split result in a decrease of carbon dioxide emissions. For instance, if globalization leads to the use of less environmentally damaging transport modes (such as rail or inland waterways) instead of more environmentally-damaging transport modes (such as road and air transport), the result will be a fall in emissions.

2. STRUCTURAL EFFECTS

Structural effects involve changes in the country of origin and destination of goods. If globalization leads to the transportation of goods over a long distance, the effects on the environment in terms of carbon dioxide emissions will be negative. However, it should be stressed that it has often been argued that it is regionalization, as opposed to globalization, of international trade that is taking place. This may imply that international transport flows have a regional (in this case European) rather than an intercontinental character.

3. TECHNOLOGICAL EFFECTS

Technological effects reflect changes in transportation technologies, logistic systems and so on. In this connection we may refer to the innovation and implementation of new transport technologies, such as more efficient engines, and changes in logistic systems, such as route-planning systems. As a consequence, a reduction of emissions per t/km may result from these new technologies.

4. PRODUCT EFFECTS

Product effects involve changes in the 'product mix'. Different categories of products can be distinguished, such as petroleum, metals and food. The composition of the product mix determines to a large extent

not only the volume of transported goods but also the transport mode that will be used. For instance, a change in the product mix towards products with a high value but a low volume may result in a decline in the volume of commodity flows (scale effects). However, the transportation of more high value products may also lead to the use of more environmentally-damaging modes. Therefore, positive volume effects of changes in the product mix can be cancelled out by changes in modal split, and vice versa.

The complex relationship between trade, transport and the environment needs to be analysed at different, relevant geographic scale levels. The driving forces of this complex phenomenon differ also for different spatial scales. Examples are the rise in income, the increase in leisure time, the emergence of new technologies (including ICT) and the ageing population. Against this background the use of scenario analysis methods may be helpful, as they are tools to test the sensitivity and resilience of policy measures or strategies aimed at improving environmental quality.

The transportation sector is complex, complexity that is to a large extent a derived demand that is determined by developments in other sectors. This can be exemplified by referring to changes in technology, decentralization of governments or changes in the composition of households. But also inside the transport sector major developments are taking place, such as new logistics, advanced vehicle technology or sophisticated route guidance systems.

From the set of external forces globalization plays a major role, as this is influencing trade and transport at all geographic scale levels. Globalization means more intensive network contacts, market expansion and higher mobility of production factors. It also stimulates the introduction of new goods and services, as well as a relocation of industries.

Against this background at each geographical scale level (e.g. global, European, Dutch) four types of scenario have been designed in a consistent way. At the global and European level these scenarios describe images in the area of production, consumption, trade and welfare distribution up to the period 2020 and 2050. The consequences of each of these scenarios are then systematically mapped out. The qualitative underpinnings of the various scenarios are next systematically translated into relevant parameters to be inserted into an integrated assessment model – such as the *WorldScan* model of the Dutch Central Planning Bureau.

It is also possible to derive systematically from each of these global

scenarios corresponding transportation scenarios at both the global and the European as well as at the national Dutch level. By means of these transportation scenarios it is possible to map out the changes per region and per transport modality for passenger and freight transport, given the outcomes for trade and economic growth from the above mentioned globalization scenarios. When an assessment of the various volumes of transport for each scenario has been made, it is possible to estimate the corresponding carbon dioxide emissions. Finally, it is necessary to consider and to introduce policy measures in the form of compound policy packages. In many policy studies various policy packages are then composed (e.g. in the field of transport or environmental policy). In this way one can investigate – by means of a sensitivity analysis at the interface of external scenario developments and indigenous policy responses – the resilience of economic developments and policy frameworks for environmental sustainability.

We may illustrate the above methodology by reference to the European level, for which four relevant and consistent transportation scenarios have been designed and deployed, in which also a distinction between eastern and western Europe was made. The ingredients of each of these scenarios are: geographical development, distance, technological development and modal split. Each of the scenarios leads to different volumes of transport and hence different environmental implications. The scenarios distinguished in the European case are: growth, core-growth, peripheral growth and sustainable growth. Each of these scenarios differs in regard to changes in economic growth and trade, and hence leads to different driving parameters in the macro-economic assessment model. For example, in the growth scenario the assumption is made that there will be a strong rise in economic development and trade in both eastern and western Europe, leading to an increase in international transport. It goes without saying that in the latter case a continuation of high carbon dioxide levels is unavoidable. In the sustainable growth scenario, however, it appears to be possible to reduce carbon dioxide emissions significantly.

The assessment of environmental effects of rising transportation volumes should of course also include two important factors, viz. the energy efficiency of transport systems (e.g. in terms of advanced environmentally benign vehicle technology) and the policy response of public decision-makers. In general, it is possible to generate a significant contribution to a more sustainable transport system through the use of energy saving technologies or the adoption of new logistic concepts. Next, by implementing regulatory systems on transport

systems (e.g. modal split, energy efficiency standards, etc.) a higher degree of sustainability can be achieved, in particular if such a policy is supported by flanking measures based on market incentives (e.g. pricing, subsidies, etc.). In general, a single policy measure does not seem to offer a clear contribution, and therefore it is a wise strategy to develop policy portfolios that comprise packages of various policy instruments, in which both financial, technological, ecological and land use elements are incorporated. It turns out that such portfolios are able to create more effective outcomes for sustainable transport policies.

Finally, the geographical dimension is important, so that at various spatial scale levels (e.g. global, European, Dutch) policy-relevant scenarios can be developed. Then followed by the design of policy packages as a response to external challenges with a view to the achievement of environmentally sustainable outcomes in various parts of our world. Such approaches would also include various transport modalities (e.g. road, railways, waterways, aviation, etc.).

It is not very likely that the volume of transport (both passenger and goods) will decline in the future. But it is possible to organize transportation in a more intelligent way, for example, through intermodal solutions, the application of new logistic concepts, the adoption of energy saving vehicle technologies, etc. Clearly, land use policy may also offer a significant contribution. The achievement of the so-called Kyoto norms with at least an 8% reduction in the period 1990–2012 is only a first step and very difficult to realize. To have a more significant reduction in the carbon dioxide volumes requires more strict regulatory systems, in which both a system of environmental standards and market prices play a critical role.